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Remarks

Thorough examination by the Examiner is noted and appreciated.

The Claims stand as previously presented and have been listed above.

Applicants respectfully request reconsideration of Examiners rejections.

Claim Rejections under 35 USC 112

1. Claims 1-9 are rejected under 35 USC 112, first paragraph as containing subject matter which was not described in the Specification in such a way as to reasonably convey to one skilled in the art that the inventors at the time of the application was filed, has possession of the claimed invention.

Applicants respectfully disagree. In support of the amendment in the previous office action Applicants clearly pointed to support in the Specification for "a copper oxide containing surface" including reproducing portions of paragraph 0028 of which a portion is again reproduced below:

"For example, Figure 4 shows cyclic voltometry data of a copper electrode in an acidic cleaning solution with a pH of about 4. The vertical

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axis is the log of current density while the horizontal axis is oxidation potential in Volts versus a reference Ag/AgCl electrode. Other relevant operating parameters include a spin rate for the electrode of about 2000 rpm and a scan rate of about 0.01 V/sec. Line A represents the electrochemical oxidation potential under normal conditions including having the electrode subject to incident light (having a wavelength of about 350 to about 700 nm) while contacting the cleaning solution. Line B represents the electrochemical oxidation potential under substantially light shielded conditions (dark conditions), e.g., incident light upon the electrode while in contact with the cleaning solution is substantially blocked from impacting the electrode. The shift of the minimum (e.g., C1) in current density to more positive electrochemical oxidation potential under dark conditions (e.g., C2) is analogous to what is believed to be an increase of the activation energy for formation of copper oxide (e.g., CuO or Cu<sub>2</sub>O) or copper hydroxide (e.g., Cu(OH)<sub>2</sub>) thereby slowing the rate of erosion of the copper metal interconnect lines."

Also see paragraph 0029:

"The electrolysis reaction may be related to activation of a material included in the substrate surface, for example copper or copper oxide (CuO, Cu<sub>2</sub>O) together with electrochemical half-reactions in an associated electrolyte solution. Copper oxide is typically present over copper surface due to ambient oxidation processes. The term "copper" as used herein includes copper, and alloys thereof to include copper oxide, e.g., (CuO, Cu<sub>2</sub>O)."

"The fundamental factual inquiry is whether the specification conveys with reasonable clarity to those skilled in the art that, as of the filing date sought, applicant was in possession of the invention as now claimed." See, e.g., *Vas-Cath, Inc.*, 935 F.2d at 1563-64, 19 USPQ2d at 1117.

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"Possession may be shown in many ways. For example, possession may be shown by describing an actual reduction to practice of the claimed invention. Possession may also be shown by a clear depiction of the invention in detailed drawings or in structural chemical formulas which permit a person skilled in the art to clearly recognize that applicant had possession of the claimed invention. An adequate written description of the invention may be shown by any description of sufficient, relevant, identifying characteristics so long as a person skilled in the art would recognize that the inventor had possession of the claimed invention." See, e.g., *Purdue Pharma L.P. v. Faulding Inc.*, 230 F.3d 1320, 1323, 56 USPQ2d 1481, 1483 (Fed. Cir. 2000).

Applicants respectfully suggest that Examiner's rejection is without merit.

**Claim Rejections under 35 USC 103**

2. Claims 1-12, 14, and 16-21 stand rejected under 35 USC 103(a) as being unpatentable over by Edelstein et al. (US 6,251,787 or 6,153,043), in view of Chang et al (US 6,323,131), Zhang et al. (6,162,301), and Kneer (US 6,147,002).

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Note that column and line number citations are with respect to Edelstein et al. '787, though similar or the same disclosure is found in '043.

Edelstein et al. disclose and teach **eliminating exposure of PN junctions to light** capable of invoking a **photovoltaic reaction** to prevent electrochemical dissolution of metal components in contact with an electrolyte (see Abstract; col 5, lines 25-34).

Edelstein et al. further teach that PN junctions are formed by introducing impurity atoms into areas of a semiconductor wafer (col 5, lines 10-13) and further teaches that exposure of the PN junctions to light of certain wavelengths essentially acts as a battery supplying current to metal interconnects (col 5, lines 29-34) which, when in contact with an electrolyte can lead to electrochemical dissolution of the metal. Edelstein teaches eliminating exposure of **semiconductor PN junctions** to light having wavelengths less than about 1.1 micron for **silicon wafers** and 0.9 microns for **GaAs wafers** (col 5, lines 52-59).

Edelstein et al. generally disclose that in general, tools such as wafer CMP, brush cleaning, unloading and rinsing should have a **darkened enclosure** to eliminate exposure of PN junctions,

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specifically disclosing CMP, brush cleaning, unloading, and rinsing (col 7, lines 56-57). It is therefore clear from the teachings of Edelstein et al. that illumination from the backside ~~or~~ the front side of the wafer would have the same effect. The principal of operation of the method of Edelstein et al. is different in operation and effect than the method of Applicants, and illumination from the backside of a wafer would not create the problem that Applicants disclosed and claimed invention solves.

In contrast, Applicants claimed invention claims:

"A method for preventing photo-induced **chemical attack** on a copper oxide containing surface comprising the steps of:

providing a substrate comprising a dielectric material and an exposed copper containing surface comprising copper oxide;

providing an acidic cleaning solution for contacting the exposed copper containing surface; and,

shielding the exposed copper containing surface to substantially block incident light from impacting the exposed copper containing surface while contacting the exposed copper containing surface with the acidic cleaning solution."

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Moreover, nowhere do Edelstein et al. disclose an acidic cleaning solution for contacting an exposed copper containing surface comprising copper oxide.

In addition, nowhere do Edelstein et al. disclose or teach "shielding the exposed copper containing surface to substantially block incident light from impacting the exposed copper containing surface while contacting the exposed copper containing surface with the acidic cleaning solution".

Nowhere do Edelstein et al. disclose exposed copper surfaces comprising copper oxide.

Nowhere do Edelstein et al. disclose a photo-induced chemical attack on copper oxide. Applicants do not disclose or claim a photovoltaic effect involving a PN junction in a semiconductor wafer.

The disclosure of Applicant, as the experimental section makes clear, is a method for preventing **photo-induced chemical attack** on a copper oxide containing surface as Applicants have claimed. Note that Applicants have defined the term copper to include copper, and alloys thereof to include copper oxide, e.g., (CuO, Cu<sub>2</sub>O) (see last sentence in paragraph 0029).

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Applicants do not claim a PN junction or claim a copper containing feature in contact with a PN junction. Metal interconnects are not necessarily in contact with PN junctions.

Applicants do not disclose or teach that illumination of a PN junction and associated electrolysis as the principal of operation as Applicants make apparent in the Specification by the presentation of experimental results relating to light exposure of a copper electrode and a **copper oxide containing surface in contact with an acidic solution.**

"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention." *W.L. Gore & Associates, Inc., Carlock, Inc.*, 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

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With respect to claims 3 and 4, 12 and 14 Edelstein et al. neither discloses the claimed wavelength range of Applicants nor the pH range of Applicants.

Applicants note that Examiner admits that Edelstein et al. do not teach or disclose an acidic cleaning solution including Applicants claimed pH ranges.

Obeng et al. teach "a ULSI circuit chip comprising copper interconnects with a corrosion protection layer of the surface of the copper which layer is comprised of a self assembled organic monolayer" to prevent corrosion of the copper during CMP and post CMP cleaning conditions (see col 3, lines 60-64). Obeng et al teach a post CMP cleaning process with CO<sub>2</sub> sparged deionized water having a pH of about 4.

There is no apparent motive for combining Obeng et al. with Edelstein et al., other than Applicants disclosure. For example, Obeng et al. do not disclose or suggest a photo-voltaic induced erosion of copper or copper oxide or a photo-induced chemical attack of a copper oxide containing surface. The fact that acidic cleaning solutions are known in the prior art has little to do with making out a *prima facie* case of obviousness with respect Applicants claimed invention. Applicants, in discussing the



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prior art and the problem presented in the prior art (see paragraph 009), note that an acidic cleaning solution can accelerate the erosion of copper, a problem that Applicants disclosed and claimed invention solves. Thus, the combination of Obeng et al. with Edelstein et al. does nothing to help Examiner in establishing a *prima facie* case of obviousness.

Zhang et al. also teach an acidic cleaning solution for cleaning a wafer surface post-CMP following polishing a copper layer (see Abstract).

The same comments made above with respect to Obeng et al., apply to Zhang et al. There is no apparent motive for combination with Edelstein et al. except for Applicants disclosure. There is no teaching or suggestion in Zhang et al. that a post CMP cleaning process with an acidic cleaning solution may be related to a photovoltaic induced erosion of copper or copper oxide as taught by Edelstein et al. or a photo-induced chemical attack of a copper oxide containing surface as disclosed and claimed by Applicants. Even assuming *arguendo* proper motivation for combination, such combination fails to produce Applicants claimed invention or recognize or solve the problem that Applicants have recognized and solved by their disclosed and claimed invention.

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With respect to Kneer et al., Applicants reiterate the above comments made with respect to Zhang et al. and Oheng et al.. Kneer et al., also disclose an acidic cleaning solution for cleaning copper following CMP planarization. Moreover, Kneer et al. teaches a cleaning solution that **slightly etches the copper** (see col 4, lines 54 ~ 65), taught to be desirable to remove contaminants. There is no recognition or discussion in Kneer et al. that an acidic cleaning solution may be related to a photovoltaic induced erosion of copper as taught by Edelstein et al., or a photo-induced chemical attack of a copper oxide containing surface as disclosed and claimed by Applicants. Kneer et al. in combination with Edelstein et al., do not recognize the problem or provide a solution to the problem Applicants have recognized and solved by their disclosed and claimed invention;

"A method for preventing photo-induced chemical attack on a copper oxide containing surface"

Kneer et al. do not suggest or disclose that a post CMP cleaning process with an acidic cleaning solution may be related to a photo-voltaic induced erosion of copper or copper oxide as taught by Edelstein et al. or a photo-induced chemical attack of a copper oxide containing surface as disclosed and claimed by Applicants.

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Nevertheless, even assuming *arguendo* proper motivation for combining the references of Obong et al., Zhang et al., Kocer et al., the references singly or in any combination fail to produce Applicants claimed invention or recognize or solve the problem that Applicants have recognized and solved by their disclosed and claimed invention.

"First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. **Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure.**" *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

When applying 35 U.S.C. 103, the following tenets of patent law must be adhered to:

- (A) The claimed invention must be considered as a whole;
- (B) The references must be considered as a whole and must

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suggest the desirability and thus the obviousness of making the combination;

- (C) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and
- (D) Reasonable expectation of success is the standard with which obviousness is determined.

*Hodosh v. Block Drug Co., Inc.*, 786 F.2d 1136, 1143 n.5, 229 USPQ 182, 187 n.5 (Fed. Cir. 1986).

Applicants point out that "we do not pick and choose among the individual elements of assorted prior art references to recreate the claimed invention, but rather we look for some teaching or suggestion in the references to support their use in a particular claimed combination" *Symbol Technologies, Inc. v. Opticon, Inc.*, 935 F.2d 1569, 19 USPQ2d 1241 (Fed. Cir. 1991).

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)

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"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Spinnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

The claims stand as previously presented. A favorable reconsideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,



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